A POTENTIAL ROLE OF COASTAL SAGE SCRUB UNDERSTORIES IN THE RECOVERY OF CHAPARRAL AFTER FIRE

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ABSTRACT

Fifty-eight percent of the herb species recorded on recently burned sites of chaparral in southern California are to be found in the understories of southern coastal sage scrub stands that have not burned for seven years or more. Because coastal sage scrub is found near chaparral at lower elevations throughout southern California, it may serve as an important seed source for the herbland phase of chaparral succession after fire. The dispersal of seeds from sage scrub to chaparral lands each year provides an alternative to the hypothesis that post-fire herbs arise from seeds that have remained viable *in situ* for the 40–90 years or more that may intervene between fires. At the same time, it would appear that mechanisms such as increased shading, or possibly allelopathy, act to inhibit the germination of herb seeds under mature chaparral canopy. The large degree of similarity between the understory flora of mature coastal sage scrub and the post-fire flora of chaparral challenges the notion that the latter are mostly "pyrophyte endemics". The possibility of a partial dependence of chaparral succession on dispersal from coastal sage scrub suggests a new argument for the conservation of coastal sage scrub areas, remaining examples of which are currently endangered by development pressures.

The first three to six years of growth after fire in chaparral areas of California are characterized by a marked increase in growth of annual and perennial herbs. In a recent review of chaparral ecology, Hanes (1977, p. 433) has stated that "most of these herbaceous species on chaparral burns . . . are 'pyrophyte endemics,' that is, they are found on burn sites but not elsewhere." On the basis of a recently completed survey of 67 sites of coastal sage scrub in southern California, I report that a majority of post-fire chaparral herbs are to be found in the understories of coastal sage scrub sites that have not burned in at least seven years, and in most cases not for one or two decades and more.

Southern coastal sage scrub is a vegetation type dominated by drought-deciduous, mesophytic shrubs, 0.5–2.0 m tall, typically of the genera *Salvia, Encelia,* and *Eriogonum,* and by *Artemisia californica.* The community is found below 900 m elevation on the coastal and interior sides of the evergreen, sclerophyllous chaparral shrubland (2–3 m tall) of coastal mountains. Typical chaparral dominants include *Adenostoma* and *Ceanothus* spp. Recent synecological accounts of coastal sage scrub are those of Mooney (1977) and Kirkpatrick and Hutchinson (1977). If coastal sage scrub is acting as a repository and seed source for post-fire chaparral herbs, there is less need to explain post-fire herb blooms by postulating seed dormancy periods of several decades (Hanes, 1977). Secondly, it implies a partial dependence of chaparral on adjacent coastal sage scrub for post-fire successional processes that hitherto has not been considered.

Methods

Sites of southern coastal sage scrub, both coastal and inland, were sampled in a region extending from the base of the San Pedro Martir near San Telmo (Baja California) in the south, to Mt. Diablo, east of San Francisco, in the north. Sixty percent of the sites were in the region from Ventura County to the California-Mexico border, reflecting the concentration of sage scrub habitat in this region. The identity of all species within a 25 m × 25 m plot at each of 67 sites was recorded. The mean time since last fire ± std. dev. was 17 ± 9 years (range: 7–40+ years), as determined by local fire records and ages of shrub stems. Shrub stem ages provide a minimum time since past fire, so the mean figure is a conservative estimate. The influence of past grazing by sheep and cattle could not be ruled out for any site, but current grazing activity was sporadic or nonexistent in all cases. A more detailed account of the floristics and habitat features of the sites, including disturbance influences, is in preparation.

Sampling was conducted in June and July, 1977 and March–May, 1978. Seventeen of the 44 sites sampled in 1977 were revisited in the spring of 1978 to identify additional understory ephemerals. The fact that only 3.4 ± 0.7 additional species were recorded per site (31 species, total) suggests that the unusually heavy rains of the 1977–78 winter season did not increase the size of the coastal sage scrub understory flora inordinately.

Results and Discussion

The understory flora of coastal sage scrub sites that had not burned in seven years or more was compared with herbs and subshrubs found on chaparral sites that had burned or been cleared 1–4 years previously. Two of the chaparral sites were in coastal southern California (McPherson and Muller, 1969; Christensen and Muller, 1975), and two were inland (Horton and Kraebel, 1955; Vogl and Schorr, 1972). Of 111 post-fire chaparral herbs thus considered, 58 percent were found also in southern coastal sage scrub sites. Both annuals and perennials are held in common between chaparral and sage scrub by this proportion. When the fourteen introduced species (all annuals) are removed from consideration, 56 percent of species are held in common. When 44 additional post-fire chaparral herbs encountered from chaparral sites 150–300 km north (Sampson, 1944; Sweeney, 1956) of the northernmost coastal sage scrub site sampled (Mt. Diablo) are included in the comparison, the proportion of species held in common drops by only 9 percent.

These figures suggest that a substantial proportion of herbs and subshrubs appearing on post-fire chaparral sites could have arisen from seed dispersed from nearby coastal sage scrub sites. This is not to imply that the seeds have arrived only after a fire. Sweeney (1956) has shown that many post-fire chaparral herb seeds are present in the soil before a burn. Presumably, seeds arrive from adjacent coastal sage scrub sites each year, but are stimulated to germinate on chaparral sites by conditions that pertain during and following fire (Sampson, 1944; Sweeney, 1956; Hanes, 1977). While no studies have been done on seed longevity for the herbs discussed here, a study of seed viability for a selection of southern California chaparral and desert species stored in dry cabinets indicates that very few retain viability for even twenty years (Went, 1969).

The suppression of germination of many post-fire herb seeds under the canopy of mature chaparral relative to coastal sage scrub may be a function of the denser and more continuous shade under chaparral shrubs or possibly of the action of allelopathic substances associated with chaparral dominants. A number of workers have examined this question since the early studies of Went et al. (1952). McPherson and Muller (1967) have demonstrated the ability of *Ceanothus* (a chaparral shrub) to suppress *Salvia leucophylla* seedlings by shading. McPherson and Muller (1969), Chou and Muller (1972), and Christensen and Muller (1975a) have argued that light is not a factor in herb suppression in chaparral, because bare areas within chaparral occur in canopy openings. Herb suppression in bare areas has been explained in terms of grazing and seed removal by animals, patchiness in soil moisture, and allelopathy in chaparral (Muller et al., 1968; McPherson and Muller, 1969; Christensen and Muller, 1975a). Because factors contributing to herb suppression in both communities are multiple, variations in herb density in both cases are to be expected. Nevertheless, a more intense and continuous shade does distinguish the environment beneath a chaparral canopy from that beneath the canopy of coastal sage shrubs, and herbs under the canopies of the two communities may be expected to respond to this difference (see also Christensen and Muller, 1975b).

Allelopathic effects have been demonstrated in bioassays for both coastal sage scrub and chaparral species (Muller et al., 1964; McPherson and Muller, 1969). To the extent that this phenomenon applies in the field, more effective inhibition of herbs under chaparral relative to coastal sage scrub will depend upon the species density and composition of the particular stands being compared.

While areas of coastal sage scrub interdigitate with those of chaparral at lower elevations of coastal mountains and in areas of mosaic fire pattern, the contribution of the coastal sage scrub understory to seed stores in areas of chaparral remote from sage scrub sites could be expected to be less. A quantitative study of the seed reservoir of post-fire herbs in chaparral litter and surface soil at increasing distances from mature coastal sage scrub sites could help test this hypothesis.

If in fact seeds of many post-fire chaparral herbs are not of decades-long viability, but are rather renewed in quantity each year by influx from mature coastal sage scrub sites, a dependence of chaparral on sage scrub for post-fire recovery is implied. This implication has practical significance to plans for preserving examples of chaparral in the Santa Monica Mountains and elsewhere in southern California, now being considered by the U. S. Congress and other government entities. The Santa Monica Mountains Planning Commission is currently preparing a plan for the development and preservation of this area, which contains examples of both coastal sage scrub and chaparral. Legislation recently has been enacted that will permit Federal purchase of land in the Santa Monica Mountains for park purposes. It may also have significance for efforts to minimize erosion damage following recurrent chaparral fires throughout southern California. Although coastal sage scrub is a distinct community type, it is frequently not distinguished from chaparral by planners considering proposals to preserve or develop southern California shrublands. It is widely agreed by ecologists, however, that southern coastal sage scrub is one of the most endangered habitats in California (see, e.g., Hanes, 1976).

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